Reducing fuels in the Wildland Urban Interface: Community perceptions of agency fuels treatments

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Running head: Perceptions of fuels treatments

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ABSTRACT

Wildland fires and resulting impacts have increased in recent years. Efforts are underway nationwide to proactively manage vegetative conditions to reduce the threat of wildland fires. Public acceptance is critical to the successful implementation of fuels reduction programs, particularly at the Wildland Urban Interface (WUI). This study examines public acceptance of fuels treatments and influencing factors in five neighborhoods in Oregon and Utah located adjacent to public lands. Support for treatment use was high across locations. Findings suggest citizen trust in agency managers to successfully implement treatment activities is particularly influential on treatment acceptance. Thus, building and maintaining trust with local citizens is an essential element to the successful implementation of fuel management programs.

BRIEF SUMMARY

This study examined public acceptance of fuel treatments in communities adjacent to public lands. Participants were generally supportive of agency efforts to reduce wildland fuels, although acceptance levels varied between treatment types. Citizen trust in agency managers to successfully implement treatment activities had a strong influence on support.

INTRODUCTION

Across the United States there has been an increase in wildland fire activity and resulting impacts in recent years. Since 2000, the average annual acres burned has more than doubled from that of the 1990's increasing from 3.3 million acres to 7.0 million acres (wildland fire statistics available at www.nifc.gov). At the same time, a recent analysis of the Wildland Urban Interface (WUI), where structures and other human developments meet or intermingle with wildland vegetation, found that 9.4% of the U.S. land area and 38.5% of U.S. housing units were located in the WUI (Radeloff et al. 2005). Moreover, these areas are continuing to grow; a review of California, Oregon, and Washington found a 17.6% growth in WUI housing units from 1990-2000, which is substantially higher than the 13% growth seen on all lands nationally (Hammer et al. 2007). This development has put an increasing number of lives and property at risk. Several recent examples are illustrative of the potential impacts of WUI fires. In 2002, the Hayman Fire destroyed 600 structures in Colorado while the 420 structures were lost to the Rodeo-Chediski fire in Arizona. Even more dramatically, during the 2003 Cedar fire in southern California, 2,400 structures were burned. These losses come despite record federal expenditures on fire suppression in recent years, a majority of which is directed at protecting private property (USDA 2006).

Not surprisingly, wildland fire policy in the U.S. has increasingly emphasized proactive efforts to reduce the likelihood of fire (Stewart et al. 2006). These efforts consist of two primary approaches: 1) the use of fuel treatments such as prescribed fire and mechanized thinning to reduce fuel levels on public lands, and 2) encouraging property owners to take action to protect their own property. To be successful in the long run, both approaches require a supportive

constituency. A growing body of research provides evidence of increasing support for the use of fuel treatments over time (e.g., Manfredo et al. 1990, Shindler and Toman 2003, Blanchard and Ryan 2007). Findings have also indicated a number of factors that contribute to support of agency treatments including awareness of potential outcomes (e.g., Loomis et al. 2001, Brunson and Shindler 2004), citizen involvement in developing treatment plans (e.g., Winter et al. 2002, Blanchard and Ryan 2007), existence of high quality relationships between residents and agency personnel (Fleeger 2008), as well as situationally specific variables (e.g., size of treatment, proximity to homes, weather conditions, etc., Winter et al. 2002).

Research has also pointed to the importance of trust in fire management agencies (e.g., Shindler and Toman 2003, Winter et al. 2002, Vogt et al. 2005, etc.). While several researchers point to the importance of trust in fire management, trust has been conceptualized and measured in different ways across this body of research. Examples include conceptualizing trust as deriving from competence, care, and consensual values (Winter et al. 2004); similarity of values, goals, and views between the public and the managing agency (Winter and Cvetkovich 2008); shared norms and values, willingness to endorse, and perceived efficacy (Liljeblad et al. 2009); and other studies that have drawn on Hardin's (1993) concept of "encapsulated trust" where one party indicates their trust in another to engage in a particular action (e.g., Shindler and Toman 2003, Brunson and Evans 2005). This differentiation in the conceptualization of trust mirrors that within the broader social science literature. In a recent review of trust-related research, Earle (2010) reviews 132 empirical studies of trust conducted between 1986 and 2009. While this review highlights the complexity of trust research, at a general level, Earle identifies three primary approaches to conceptualizing and measuring trust—1) an emphasis on *relational trust*

based on relationships between people (or between people and an organization), 2) *calculative trust* (often referred to as confidence) which emphasizes abilities and past performance, and 3) a combined approach that includes both relational and calculative items.

In this study, trust was conceptualized following this third approach and measured with two items—a general measure of trust in natural resource agencies to make good decisions about fire and fuel management and a more specific measure of participant confidence in agency managers to use particular fuel treatments. Each of these items contained both a relational (trust in natural resource managers) and calculative component (to make good decisions about fuel management or to responsibly implement treatments). Based on these measures, trust and confidence are largely treated interchangeably in the discussion that follows. While we recognize more sophisticated measures of trust would allow a more in-depth analysis of this important concept, this study was not designed to examine the characteristics of trust but rather trust was included as one of several potential influences on acceptance of agency use of treatments.

The findings reported here build on previous research to examine the citizen acceptance of agency fuel reduction activities and influencing factors in communities at risk to wildfire impacts. The study locations include five neighborhoods in Oregon and Utah located directly adjacent to public lands. Many of the study participants owned property on the outskirts of the residential development that shared one or more borders with publicly managed lands. Given these circumstances, the fire risk of the neighborhoods is directly tied to that of the neighboring public lands. The purpose of this paper is to improve our understanding of this particularly important demographic group who are the first to be affected by treatment decisions and can

strongly influence the types of activities that occur on the public land in their backyards. For this article, the study objectives were to: (1) identify current levels of acceptance of agency fuel management efforts, and (2) examine influencing factors to citizen acceptance.

RESEARCH DESIGN

The data reported here are a subset of a larger project that uses a multiple case study design and employs qualitative and quantitative research methods to examine resident's understanding, attitudes, and behaviors regarding wildfire risk and mitigation in five WUI communities in central Oregon and southwestern Utah (Table 1). A case study is defined as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context" (Yin 2003, p. 13). The multiple case study design allows analysis of property owner attitudes and behaviors towards fire and fuel management within the context of their specific location (an individual case) as well as comparisons and conclusions to be drawn across the different locations. In a multiple case study design, cases are selected following replication and not sampling logic (Yin 2003). That is, locations are selected based on known similarities and differences in the specific context that enable a richer understanding of resulting findings by comparisons across sites.

The research team traveled to prospective study locations to meet with local agency personnel and community leaders (e.g., members of the homeowners' association board) to gain an in-depth understanding of the local fire and fuel conditions, ongoing fire mitigation programs, and accompanying public engagement activities in each location. Locations were then purposefully chosen that represented a range of different vegetation conditions, mitigation programs, and engagement activities. In a multiple case study design, the cases represent the unit of analysis

(Yin 2003). For this study, the selected neighborhoods represent our unit of analysis, while our unit of observation (e.g., the unit on which data is collected) is individuals within those neighborhoods. Following the selection of study locations, the research team worked with local community leaders to identify potential study participants. Participants were purposefully selected to represent a range of participation in fuel reduction programs, seasonal and permanent residency, and proximity to publicly managed lands.

Data for this project were collected in two phases. First, the research team met with homeowners on-site and completed a structured interview following a protocol modified from Nelson et al. (2005). The protocol consisted of a series of closed and open-ended questions that explored the behaviors taken by landowners to reduce their fire risk, the factors that influenced their adoption of those behaviors, and perceived outcomes of resulting treatments. In each location, the research team sent a brief cover letter to neighborhood residents describing the project and the timeframe the team would be in the neighborhood. One week prior to our visit to each location, a member of the research team called potential participants to request participation in the study and schedule an interview at the homeowner's property. Nearly all residents who were contacted expressed a willingness to participate in the study, although some were unable to due to scheduling difficulties.

The second phase of the project consisted of a brief survey distributed to all interview participants. This survey was comprised of mostly closed-ended questions probing experiences and preferences regarding fire management activities on nearby public lands. The data presented here come from this second portion of the project. For this data, our primary interest was in

examining the factors that influence acceptance of agency fuel reduction activities in neighborhoods adjacent to public lands.

Building on prior research, we expected a direct association between acceptance levels and citizen perceptions of agency management, ratings of citizen-agency relationships, and trust in agency managers (e.g., Winter et al. 2002, Shindler and Toman 2003, Blanchard and Ryan 2007, Fleeger 2008). We also expected responses would vary across locations (Manfredo et al. 1990, Brunson and Shindler 2004). In addition, our initial site visits and interviews with agency personnel and community leaders revealed other commonly held assumptions that the data here allow us to examine. Specifically noted was a perception that wildland fire evacuations and perceived likelihood of future fires will both lead to support for agency fuel reduction efforts, while newer and non-permanent residents tend to be less supportive of such treatments. The data here allow us to further examine the influence of these variables.

All reported percentages and resulting statistics come from closed-choice questions on the survey. Survey data were analyzed using the Statistical Package for the Social Sciences v. 17. To address our first objective in this project, we first provide descriptive statistics on citizen acceptance levels and perceptions of agency management. Using correlation analysis and logistic regression, we then examine the influence of multiple variables on acceptance of both prescribed fire and mechanized thinning activities. Given our research design, such results do not allow for statistical generalization beyond the study participants. However, findings from case study research do provide for analytic generalization, which Yin describes as generalization based on comparisons to a previously developed theory (2003). Essentially, this process involves drawing

on prior research to develop a description of expected influences on citizen acceptance. Findings are then compared to these expected relationships and analyzed for additional evidence in support of or contrary to the expected outcomes.

Overall, 158 participants completed the on-site interview with 148 also completing the follow up survey (94% completion rate). As illustrated in Table 1, the study locations vary in number of developed properties. In the three Oregon locations, the research team contacted residents until approximately 40 participated in the study. The Utah neighborhoods were smaller; Utah A had approximately 70 developed properties and Utah B had fewer than 20 homes at the time of the study. In each of these neighborhoods a sizeable proportion of property owners, including both permanent and non-permanent residents, participated in the study (more than one-fourth in Utah A and approximately half in Utah B). Given these selection rates, we feel confident the resulting samples adequately represent the selected communities.

Table 1: Site characteristics

Site Name	Forest Type	Agency responsible for nearby public lands	Parcel Size (acres)	# of existing residences	# participants
Oregon A	ponderosa pine	Deschutes National Forest	1	200	40
Oregon B	ponderosa pine	Deschutes National Forest	0.5	440	42
Oregon C	lodgepole and ponderosa pine	Deschutes National Forest, Prineville BLM, Oregon Dept. of Fish and Wildlife	0.5 – 1	100	35
Utah A	pinyon-juniper/ hardwood	Dixie National Forest, Cedar City BLM	1-2	70	21
Utah B	pinyon-juniper/ hardwood	Dixie National Forest, Cedar City BLM	2-3	17	9

Site Characteristics

Central Oregon

Oregon A and B are outlying neighborhoods of the town of Sisters (population of 1,745, elevation 3,200 feet, average annual precipitation 13.62"). Oregon A has 200, ~1 acre lots, Oregon B is composed of 440, 0.5 acre forested lots; in each neighborhood nearly all the lots have homes or other structures on them. Forests in the area are dominated by ponderosa pine and historically experienced frequent, low intensity fires. In both cases, these neighborhoods are completely surrounded by forests managed by the USDA Forest Service, Deschutes National Forest, Sisters Ranger District. In the past 5 years, there have been multiple large fires nearby; in 2006 one of these fires came close enough to warrant evacuation, but did not cause any direct damage within the neighborhoods.

Oregon C is located outside of La Pine, Oregon (population of 1,585, elevation 4,235 feet, average annual precipitation of 11.73"). The neighborhood is comprised of 102 forested lots ranging from 0.5 to 1 acre in size; most have homes or other structures on them. The surrounding forest is a mixture of lodgepole and ponderosa pines. Lodgepole pine forests are historically characterized by high intensity fires that tend to occur less frequently than the classic ponderosa pine fire regime. Adjacent public forests are managed by the USDOI Bureau of Land Management (Prineville District), USDA Forest Service (Deschutes National Forest, Bend Fort Rock Ranger District), and Oregon Department of Fish and Wildlife. While several fires have occurred in the general area in recent years, none have directly impacted the neighborhood.

Deschutes County is one of 11 counties in Oregon that is covered by the Oregon Forestland-Urban Interface Protection Act of 1997, a unique law that requires landowners in communities at high risk from wildfire to reduce vegetation around structures, along driveways, and around property lines. Once work has been completed the property is evaluated and certified. If a landowner fails to become certified, they are potentially liable for up to $100,000 of fire suppression costs if a fire starts on their land.

Cedar City Area, Utah

Cedar City (population 25,665, elevation 5,834, average annual precipitation is 10.64") is located in southwestern Utah. We selected two neighborhoods in this area; Utah A is located just outside city limits, and Utah B is approximately 20 miles to the south. Nearby public lands are managed by the Dixie National Forest and the Bureau of Land Management Cedar City Field Office. The forests within and surrounding the neighborhoods are characterized as pinyon-juniper/hardwood. The historic fire regime is complex, with some areas experiencing frequent, low intensity fire and others characterized by high intensity, infrequent fire (Paysen *et al.*, 2000).

Utah A is located on a steep slope with 165 forested lots, ranging from 1-2 acres in size; less than half of the lots have homes or structures on them. The neighborhood has a formal homeowner group run by elected property owners. The responsibilities of one board member are wholly dedicated to fire prevention, while other officers are also involved in fire safety efforts. The neighborhood works closely with the Utah Division of Forestry, Fire and State Lands in a program that provides matching funds or assistance with chipping or removal of treated

vegetation for homeowner hours dedicated to creating defensible space. At the time of this study, the neighborhood had not been directly threatened by wildfire.

Utah B is composed of 33 forested lots, 2-3 acres in size; just over half have homes on them. In 2005, the neighborhood was evacuated due to a fast moving, large wildfire. While no homes were destroyed, one was damaged from radiant heat and several experienced smoke damage. Vegetation on several vacant lots and common areas was also burned. The neighborhood does not have a formal homeowners' association. However, following the fire, neighbors began to work together to improve their fire safety. Residents in Utah B have received assistance from the Utah Division of Forestry, Fire and State Lands, particularly with chipping of removed vegetation.

RESULTS

This section provides descriptive information regarding participants' demographic information, perceptions of forest management and management agencies, and trust in management agencies. We then present a correlation analysis of the strength of association between presented variables and acceptance of treatment programs. Lastly, based on the correlation results, three logistic regression models are developed to examine the relative influence of potential factors on participant acceptance of fuel treatment programs.

Site characteristics and demographic information

As noted in Table 2, nearly all the participants in three locations (Oregon A, B and Utah B) and a majority of those in OR C were permanent residents. Just under than half of participants in UT A

lived on–site year round. A majority of participants was retired in each of the Oregon locations. The proportion of participants with a 4-year college degree varied from approximately half in OR A, OR C, and UT A to large majorities in the other locations. In four of the locations, residents had lived in the region for approximately 10 years on average, while the median length of residency for those in UT A was only five years. As noted above, three of the neighborhoods, OR A, OR C, and UT B, had recently been evacuated due to a wildland fire though no houses were lost in any of the locations. Lastly, participants were asked to rank the likelihood that a large wildfire would occur in their area in the next 5 years. In all locations, participants indicated a future fire was fairly likely with responses ranging from 2.63 to 3.61 on a 4-point scale.

Table 2: Site characteristics and demographic information

Site	% participants permanent residents*	% participants retired*	% participants with a college degree*	Median length of residency (years)	Recently evacuated	Perceived likelihood of future fire[a]
Oregon A	97	55	47	13	Yes	3.61
Oregon B	100	69	64	12	Yes	3.24
Oregon C	59	56	53	11	No	2.63
Utah A	47	33	53	5	No	3.00
Utah B	100	22	100	10	Yes	3.44

* Significantly different at $p < .05$

[a] Mean rating on 4 point scale (from 1 = not at all to 4 = very likely)

Perceptions of forest management

Participants provided some general information about their perceptions of forest management (Table 3). Large majorities rated agency management of public lands as excellent or good in each study site. A majority in each location also indicated agency managers were doing an excellent or good job in reducing the threat of wildfires. Lastly, participants were asked to

characterize the relationship of the local forest agency with community residents. Responses to this item were quite positive; nearly all participants indicated these relationships were good or excellent.

Table 3: Perceptions of agency management

	Percent of responses					
	OR A	**OR B**	**OR C**	**UT A**	**UT B**	**Overall Sample**
Ratings of agency management of public lands in general						
Excellent	16	10	6	38	0	14
Good	74	75	66	29	89	67
Fair	10	13	26	33	11	18
Poor	0	3	3	0	0	1
Ratings of agency management to reduce the threat of wildfire						
Excellent	11	10	9	48	0	15
Good	66	68	69	19	67	60
Fair	24	20	20	33	33	24
Poor	0	0	3	0	0	1
Ratings of agency's relationship with local community						
Excellent	40	53	29	58	22	42
Good	53	35	65	32	67	48
Fair	8	10	3	11	11	8
Poor	0	3	3	0	0	2

Acceptance of fuel management on public lands

Participants were then asked to indicate the acceptability of four different methods to reduce fuel loads on public lands (mechanical thinning, mowing of understory vegetation, herbicide application, and prescribed fire—both around neighborhoods and in remote forest areas). Responses were on a five-point scale from totally unacceptable to totally acceptable with a neutral midpoint. A "not sure" response was also included for those who felt they did not have enough information about a specific practice to make a decision. For presentation purposes, the response categories are collapsed (e.g., totally and somewhat responses were combined) in the tables below.

Table 4 presents responses on mechanical fuel treatments and herbicide use. Overall, mechanical thinning received the highest levels of support of all treatment options with at least two-thirds rating it acceptable in each of the study locations. Mowing understory vegetation was also acceptable to a majority of participants in each location, although there was less certainty about this practice with a relatively high proportion of neutral or not sure responses. Notably, a substantial number of participants in UT A indicated such treatments were unacceptable, likely a reflection of the local terrain, as the steep slope made mowing impractical. Responses were substantially less positive regarding the use of herbicides. In each location the greatest proportion of participants indicated this treatment was unacceptable while high numbers were also neutral or unsure about its use.

Table 4: Acceptability of mechanical fuel reduction treatments

	Percent of responses					
Practice and acceptance	**OR A**	**OR B**	**OR C**	**UT A**	**UT B**	**Overall Sample**
Mechanical Thinning						
Acceptable	75	91	86	67	89	83
Neutral	5	5	0	5	11	4
Unacceptable	18	5	14	19	0	12
Not Sure	3	0	0	10	0	2
Mowing Understory Vegetation						
Acceptable	58	69	77	62	89	68
Neutral	20	19	3	0	11	12
Unacceptable	10	10	17	29	0	14
Not Sure	13	2	3	10	0	6
Use of Herbicides						
Acceptable	13	26	34	29	33	25
Neutral	15	26	20	14	22	20
Unacceptable	48	33	37	33	44	39
Not Sure	25	14	9	24	0	16

As previous research has indicated citizen support for the use of prescribed fire may be influenced by the proximity of treatments to residential areas (e.g., Winter et al. 2002), participants were asked to indicate their acceptance for prescribed fire use near neighborhoods as well as in remote forest areas (Table 5). In all but one location, a majority of participants rated prescribed fire as an acceptable management practice. Participants from UT A were the most skeptical about the use of prescribed fire; only 38% indicated such treatments were acceptable near neighborhoods while slightly more (43%) were willing to accept its use in remote areas. In the other locations, at least 57% indicated prescribed fire was an acceptable practice regardless of where it would be used. However, responses also suggest there is less agreement on the use of prescribed fire near neighborhoods. In each study site, more participants indicated prescribed fire was unacceptable near neighborhoods than in remote areas.

Table 5: Acceptability of prescribed fire

	Percent of responses					
Practice and acceptability	**OR A**	**OR B**	**OR C**	**UT A**	**UT B**	**Overall Sample**
Prescribed Fire Around Neighborhoods						
Acceptable	68	69	57	38	78	62
Neutral	8	5	14	5	0	8
Unacceptable	23	24	29	38	22	27
Not Sure	3	2	0	19	0	4
Prescribed Fire in Remote Forest Areas						
Acceptable	63	81	63	43	78	66
Neutral	15	5	23	10	11	13
Unacceptable	20	7	6	29	11	14
Not Sure	3	7	9	19	0	8

Trust in agency managers

Using a 4-point scale (*none, limited, moderate, full*) with a *not sure* option, participants were asked to indicate their level of trust in management agencies to make *good decisions about wildfires and fire prevention* (Table 6). At this general level, participants expressed a high level of trust, with a majority in each location indicating they had moderate to full trust in managers in both state and federal agencies. Participants were more likely to select "not sure" for those agencies that did not have much management presence in their area.

Table 6: Trust in agency managers to make good decisions about wildfires and fire prevention.

	Level of Trust	OR A	OR B	OR C	UT A	UT B	Overall Sample
State management agency	**Full**	46	49	46	33	22	43
	Moderate	33	42	39	43	78	41
	Limited	10	7	3	5	0	6
	None	3	0	0	0	0	1
	Not Sure	8	2	12	19	0	8
USDA Forest Service	**Full**	39	46	33	48	11	39
	Moderate	44	34	42	29	78	41
	Limited	8	12	12	10	0	10
	None	5	0	3	5	0	3
	Not Sure	5	7	9	10	11	8
DOI Bureau of Land Management	**Full**	13	20	42	29	33	25
	Moderate	39	32	42	38	56	39
	Limited	15	15	6	14	11	13
	None	8	2	3	0	0	4
	Not Sure	26	32	6	19	0	20

Participants were then asked to indicate their level of confidence in agency personnel to use specific treatments to reduce the threat of wildfire. Using the same scale as above, participants indicated their confidence in agency managers to responsibly use thinning and prescribed fire treatments (Table 7). Respondents were the most positive about thinning treatments. Nearly half expressed full confidence in agency managers with at least another quarter indicating a moderate level of confidence to use thinning to reduce forest fuels. In each location, there was a decrease

in the number of participants indicating they had full confidence in agency managers to use prescribed fire; UT A experienced the most dramatic decrease (from 62% to 33% expressing full trust). Despite these decreases, strong majorities in each site still indicated either moderate or full confidence for prescribed fire use (ranging from 66% in UT A to 91% in OR B). For both of these treatments, there were higher levels of not sure responses in the Utah sites.

Table 7: Confidence in agency managers to use particular management practices to reduce wildfire risk

Management Practice	Level of Confidence	OR A	OR B	OR C	UT A	UT B	Overall Sample
Thinning to Reduce Forest Fuels	Full	53	57	46	62	44	53
	Moderate	28	29	40	24	22	30
	Limited	13	10	9	5	11	10
	None	5	2	3	0	0	3
	Not Sure	3	2	3	10	22	5
Prescribed Fire	Full	45	48	31	33	33	40
	Moderate	40	43	43	33	56	42
	Limited	5	7	14	14	0	9
	None	3	2	6	5	0	3
	Not Sure	8	0	6	14	11	6

Influences on treatment acceptability

Correlations

Our final objective with this paper was to examine the factors that influence treatment acceptance. We calculated bivariate correlations to assess the association between the variables reported above and acceptance of the use of thinning and prescribed fire (Table 8). For most of these variables, a Pearson's correlation coefficient was calculated. However, given the levels of measurement of some of these variables a Point-Biserial correlation was used for the dichotomous independent variables "gender," "permanent residency" (coded 0 for seasonal and 1

for a permanent resident), and "evacuated due to wildfire" (coded 0 if not previously evacuated and 1 if previously evacuated). A Cramer's *V* was calculated for the categorical variables "education" and "location." Values for the Pearson's and Point-Biserial coefficients can range from -1 to +1, with values of 0 indicating no linear association and values of +1 or -1 indicating perfect linear association. The sign of the coefficient indicates the direction of the relationship. Cramer's *V* varies from 0 to 1 with higher values representing an increased strength of relationship.

Three variables below merit additional explanation. First, "ratings of agency management," is an index created by combining responses to the three questions reviewed in Table 3 above (agency management of public lands, agency efforts to reduce the threat of wildfire, and past interactions with local communities); scores could vary from 0 (if the agencies were rated "poor" on all three measures) to 9 (when receiving three ratings of "excellent"). The next two variables represent our two measures of participant trust in agency managers. "Trust-general" is an index variable measuring participant trust in federal and state agencies to make good decisions about wildfires and fire prevention. This index was created by combining participant trust levels ("full," "moderate," "limited," or "none") in the federal (USDA Forest Service and USDOI Bureau of Land Management) and state agencies working in the local area; scores ranged from 0 (if respondents indicated they had no trust in each agency) to 9 (for "full" trust). The final variable, "treatment specific confidence," is the more specific measure of participant confidence in agency managers to safely and effectively use thinning and prescribed fire practices ("results presented above in Table 7). These scores could vary from 1 (for none) to 4 ("full" confidence).

Variables demonstrating a significant correlation with any of the treatment types are shaded gray in the table below. Overall, four independent variables were associated with acceptance of one or more treatments. "Permanent residency" was significantly associated with acceptance of thinning treatments. General trust in agency managers to make good decisions about wildfire was associated with acceptance of thinning treatments as well as the use of prescribed fire in remote areas. Two variables, "ratings of agency management" and "treatment specific confidence" were directly associated with all three treatments.

Table 8: Bivariate correlation analysis between independent variables and acceptance of fuel treatments on public lands (Pearson's *r* calculated unless otherwise noted)

Independent variables	Thinning *r* (significance)	Prescribed fire near neighborhoods *r* (significance)	Prescribed fire in remote areas *r* (significance)
Age	-.064 (.456)	.055 (.529)	-.069 (.433)
Gender[a]	-.044 (.608)	.091 (.291)	.017 (.844)
Permanent residency[a]	.206 (.015)	.114 (.188)	.071 (.417)
Evacuated due to wildfire[a]	.088 (.296)	.141 (.094)	.098 (.255)
Education[b]	.226 (.105)	.201 (.345)	.199 (.401)
Location[b]	.141 (.779)	.125 (.919)	.198 (.170)
Length of residency	-.046 (.582)	-.001 (.991)	-.119 (.171)
Perceived likelihood of fire	-.059 (.489)	.098 (.256)	-.044 (.618)
Ratings of agency management	.225 (.010)	.295 (.001)	.285 (.001)
Trust-general	.197 (.022)	.160 (.064)	.187 (.033)
Treatment specific confidence	.500 (<.001)	.516 (<.001)	.432 (<.001)

[a] Point-biserial correlation calculated due to dichotomous nature of independent variable
[b] Cramer's *V* correlation calculated due to categorical nature of independent variable
Shaded variables exhibit significance at the 0.05 level or greater with acceptance of at least one of the treatments

Logistic Regression

To explore the relative influence of the variables presented here on treatment acceptability, we dichotomized responses to the acceptability questions presented in Tables 4 and 5 (with 1 representing responses indicating the treatment is "somewhat" or "totally" acceptable and 0 representing all other responses --"somewhat" or "totally" unacceptable, "neutral," and "not sure"). We then used logistic regression to examine the influence of four independent variables on acceptance of the use of thinning and prescribed fire close to neighborhoods and in remote areas. Independent variables were included based on their performance in the correlation analysis; all variables that had demonstrated a significant correlation with any of the three treatments were included in the logistic regression analysis. The resulting models are presented below (Table 9).

The chi-square statistics for all three models are statistically significant, indicating the combination of independent variables in the model significantly influence treatment acceptability. Each model was also successful in classifying at least 75% of cases. Also displayed is the Nagelkerke R^2, which provides an estimate of the variance predicted by each model (Vaske 2008); the explained variance ranges from a high of 31.2% for acceptability of prescribed fire near neighborhood to 18.4% for the use of prescribed fire in remote areas. To test for multicollinearity among the predictor variables, we calculated the variance inflation factor (VIF). A VIF greater than or equal to 4 is generally considered to indicate a problem with multicollinearity (Vaske 2008). In our models, no variable exhibited a VIF over 1.37.

Table 9: Logistic regression estimates predicting treatment acceptance

Variable	Thinning	Prescribed Fire Near Neighborhoods	Prescribed Fire in Remote Areas
	β (Sig.)	β (Sig.)	β (Sig.)
Permanent residency	1.425 (.055)	.007 (.991)	-.279 (.653)
Ratings of agency management Index: 0-9 (Ratings of general management, reducing threat of fire, relationship with community)	.018 (.198)	.084 (.599)	.218 (.179)
Trust-general Index: 0-9 (Trust in state, fed agencies)	-.225 (.198)	-.052 (.705)	-.172 (.214)
Treatment specific confidence	1.828 (<.001)	1.525 (.004)	.990 (.002)
Chi-square	29.239 (<.001)	31.249 (<.001)	18.352 (.001)
Percent correctly classified	88.0	74.6	77.1
Nagelkerke R^2	.376	.321	.205

Variance inflation factor ≤ 1.37 for all independent variables
Shaded variables exhibit correlations significant at the 0.05 level with at least one of the treatments

Despite the significant correlations reported in Table 8, three variables–"permanent residency," "ratings of agency management," and the general measure of "trust" in agencies to make good decisions about fire and fuel management–did not significantly influence acceptance of thinning or prescribed fire treatments. Only the final variable, "treatment specific confidence," was significant in any of the models. Results indicate that as confidence in managers to use a specific treatment increased so did acceptance of its use. Indeed, a one-unit increase in treatment specific confidence (e.g., from moderate to full) is predicted to increase acceptance by at least a factor of 6.2 for thinning, 4.6 for prescribed fire near neighborhoods, and 2.7 for prescribed fire in remote areas.

DISCUSSION

Several noteworthy findings emerge from these data regarding acceptance of fuels management practices among citizens living directly adjacent to public lands in five locations in the western U.S. First, there is substantial evidence that participants in each of the study locations think highly of the federal and state managers working in their area. While there was some variation in specific response levels, strong majorities gave agency managers high ratings both for their general management efforts as well as their actions to reduce the threat of fire. Even more striking, nearly all participants indicated a good relationship existed between local managers and community members. Such results may be surprising given the often contentious debate surrounding many forest management decisions in recent years. Research to date has identified mixed results regarding current relationships between citizens and fire managers; while Fleeger (2008) found positive relationships between citizen and fire managers in Arizona, results from Oregon suggest such findings are not universal (e.g., Shindler and Toman 2003). What is consistent across multiple studies, however, is the importance of these relationships to citizen support of agency fuel reduction activities (e.g., Winter et al. 2002, Shindler and Toman 2003, Fleeger 2008).

Next, findings demonstrated relatively strong support for agency actions to actively reduce fuel loads on federal lands adjacent to participant communities. Mechanical thinning treatments received the highest support across the five study sites. A majority in each location also indicated acceptance of mowing understory vegetation. Except in UT A, similar numbers also indicated acceptance of the use of prescribed fire both near neighborhoods and in remote forest areas. Interestingly, acceptance of the use of prescribed fire near neighborhoods was highest in those

locations that had been most directly impacted by wildfire—UT B, OR A, and OR B. Only herbicides failed to receive much support; responses reflect both a lack of acceptance and a great deal of uncertainty with this potential method.

The final objective of this paper was to examine the factors that influence acceptance of treatments in the study locations. As suggested by prior literature, we expected treatment acceptance would likely vary across locations, and would be influenced by perceptions of agency management and interactions with local residents, and trust in managers (e.g., Winter et al. 2002, Vogt et al. 2005, Blanchard and Ryan 2007, Fleeger 2008). We also examined other variables often assumed by managers and some community leaders, including those within the study locations, to have a strong influence on citizen support for fuel treatments. These variables included recent evacuations due to fire events and higher perceived likelihood of future fires, both of which were assumed to positively influence treatment acceptance, while newly arrived and seasonal residents were presumed to exhibit lower acceptance.

Our analysis revealed very few significant associations between the potential explanatory variables and acceptance levels. Indeed, of the 11 variables examined, only four exhibited correlations significant at the 0.05 level—permanent residency, ratings of agency management, general trust in federal and state managers to make good decisions about fire and fuel management, and confidence in managers to use the specific treatment effectively. While the correlation results provided initial support for some of the expected relationships, they failed to provide support for the expected variation across study locations. Nor was there evidence that

treatment acceptance is influenced by whether participants were evacuated or the perceived likelihood of a future fire.

The further analysis of potential influencing factors through the logistic regression models also failed to provide support for three of the remaining variables—permanent versus seasonal residency, ratings of agency management, and general trust in managers. Of the four variables that were significantly correlated with treatment acceptance, only one, confidence in managers to use the specific treatment, significantly influenced acceptance levels in the logistic regression models. Serving to further emphasize the importance of this specific measure of trust, this variable significantly influenced acceptance for all three treatments even after accounting for the influence of permanent residency status, ratings of agency management, and general trust in managers.

Like much of the prior research on wildland fire, this study indicates trust in management agencies is a key influence on citizen support for agency management activities (e.g., Shindler and Toman 2003, Winter et al. 2004, Vaske et al. 2007). Results here also add to our understanding of this important factor by suggesting a key element of trust is that specific in managers to implement a particular management activity. Ultimately, while citizens may trust management agencies at a general level to make good decisions about wildland fire and fuel management, that general trust may not necessarily translate into trust in managers to implement specific fuel treatment activities. These findings highlight the complex nature of trust. Given the importance of this concept to citizen support for management activities, these results also emphasize the value of those efforts that have been made to date to more specifically examine

the dimensions of trust in fire management (Winter et al. 2004, Winter and Cvetkovich 2008, and Liljeblad et al. 2009).

CONCLUSION

Public acceptance is vital to successful implementation of treatments to reduce the fire risk. This is particularly true at the WUI, where local residents not only influence agency efforts to reduce fuel levels on public lands, but also play a key role in reducing overall fire risk through actions on their own property. Interestingly, despite the multiple contextual differences between locations in this study (e.g., surrounding forest type, percent permanent residents, recent evacuations, etc.), responses here were marked more by their commonalities than differences. To be clear, these findings do not suggest the local context is unimportant to the acceptance of fuel programs. Rather, these findings suggest certain factors, particularly trust in managers to implement specific treatments, are likely to influence treatment acceptance across locations. Just as fire and fuel management plans are based on consistent ecological principles, which are then adapted to address the specific ecological conditions at the treatment site, building and maintaining trust at the local level will require attention to the social context in each location. Residents evaluate the acceptability of agencies using treatments within their local context; thus, ratings reflect individual and social influences as well as the history of management activities in each of these locations.

While dedicating limited resources to building and maintaining citizen trust may seem peripheral to agency objectives, doing so is important to long-term management success. Accordingly, it is important to invest in the development of such trust through engaging and working with local

residents. In addition, it is also important to recognize that trust is also influenced by the perceived competence and past performance of agency managers. Thus, effectively implementing management activities will not only result in the accomplishment of management objectives but can also contribute to the development of trust. As demonstrated in these locations, when such factors are in place, managers can enjoy strong support for fire and fuel management programs, even among those most directly impacted by management activities.

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